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Essay review

Metaphors and tracers: Radioactivity in twentieth-century biology

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Life Atomic: A History of Radioisotopes in Science and Medicine, Angela Creager. University of Chicago Press, Chicago (2013). pp. 512, Price: $45.00 cloth, ISBN: 9780226017808

Radium and the Secret of Life, Luis Campos. University of Chicago Press, Chicago (2015). pp. 352, Price: $55.00 cloth, ISBN: 9780226238272

Radiation and its dangers are established tropes in the history of twentieth-century life sciences. The literature on nuclear weapons, power and disasters is vast, and much excellent research has highlighted the importance of the Atomic bomb, mutagenic effects of radiation and nuclear politics for Cold War biology and medicine.[1] These studies tended to either highlight the importance of nuclear programmes for specific research questions, or focus on the construction and experience of patients and sufferers of nuclear warfare and accidents. Beyond being a subject of investigation or political activity, however, radioactive elements have been integral instruments in biological laboratories and hospitals, as two recent books amply demonstrate. These books follow the material and intellectual trajectories of radium and radioactive isotopes that were eagerly adopted by biologists, and pay close attention to the various publics that engaged with these technologies. While different in approach, focus and scope, they revise the outdated narratives about the encroachment of physics into the life sciences, often recorded through the lens of molecular biology. Both works also expand the usual historical frameworks by taking radioactive elements as not only their subject matters, but also as an analytic tool that help interrogate these histories and structure the narrative.

1. Metaphors for life

Luis Campos's *Radium and the Secret of Life* is, deep down, the history of an idea—that radium is an element with life-like properties—with profound consequences for thinking about life in the early twentieth century. Despite this intellectual focus, the study is informed by recent scholarship on practices and material culture. Many stories of radium infrastructure, trade, medical uses and dangers have been told,[2] and recent work on plant mutagens, including radium, has also highlighted the important role of industrial and amateur users.[3] Building on this work, Campos confidently navigates through a variety of experimental communities, audiences and communications media. Starting from the bold contention that radium was understood in deeply biological ways from its discovery until the 1930s, *Radium and the Secret of Life* unpacks the ramifications of this metaphor and its effects on physicists and biologists.

Marie Curie discovered radium in 1898, soon after Roentgen reported X-rays. Both novelties fascinated physicists and lay observers alike, as they featured prominently in newsprint, magazines, books and on the public lecture circuit. The remarkable properties of radium and other radioactive elements, from transmutation to producing heat, led to comparisons with living organisms. The narratives of atomic decay fit with eugenic anxieties about evolutionary degeneration, while at the same time the element was seen as promising technological progress, thus making it emblematic of European fin-de-siècle culture. Ideas of transmutation of elements had strong parallels with evolutionary thinking and speculations about the origins of life. Physicists, journalists and novelists, from Rutherford to H. G. Wells, played fast and loose with living similes and metaphors when it came to radium. For a wide spectrum of audiences, radium came to represent an evolutionary, materialist continuity: just as life on Earth evolved, so did atoms in the universe.

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[1] See for example, Lindee (1994), Petryna (2002), de Chadarevian (2006), Kutcher (2009) and Brown (2013).

[2] Clark (1997), Rentetzi (2007, 2008), Löwy (2011, pp. 53–77) and Lavine (2013).

[3] Curry (2013, 2014).

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For Campos, the life metaphor is not merely a convenient way to domesticate a novel branch of physics. By focussing on the chemist Frederick Soddy, a prominent and prolific writer on radium, Campos argues that the metaphors and "metaphysics" of radium were entwined and co-produced. He suggests that metaphors of life came to affect his actors' thoughts about the fundamental nature of radium, and vice versa. The generative power of the life metaphor becomes a key theme of the book as it traces how this postulated relationship between metaphor and metaphysics was historically situated and eventually weakened.

Once the metaphorical connection between radium and various aspects of early-twentieth-century "life" are established, Campos considers several researchers who worked on this link. The earliest and most explicit example is John Butler Burke, a Cambridge scientist who reported remarkable effects of radium on beef bouillon in 1905. Burke observed microscopic particles, which he called "radiobes", that resembled living cells and appeared to reproduce. His reports were met with sensational coverage and seemed to suggest that radium had vitalising powers—in parallel with the explosion in patent medicines that claimed to contain radium salts and to cure all ills. Burke's work was eventually dismissed despite his respectable institutional position, largely due to failures to replicate it, but also explained by his inability to present himself as a credible expert in biology.

Campos argues that with Burke's research, radium "reached its apotheosis in experimentally vitalizing matter" (99). Moving away from such extreme claims, the next generations of scientists used radium to affect life rather than create it, and to study evolution. The remainder of the book examines the attempts to induce mutation with radium by U. S. geneticists both famous and eventually marginal: Daniel MacDougal, Charles Gager, Albert Blakeslee, Thomas Hunt Morgan, Jacques Loeb and Hermann J. Muller. None of their experiments with radium were immediate and recognised successes, although they generated promising results. Muller's experiments with X-rays in the late 1920s finally convinced geneticists that they could induce mutation with radioactivity. As Campos deftly shows, Muller's prominence and bold publishing style made his followers construct him as the father figure of induced mutation, erasing the earlier radium-based contributions. As radium was reconfigured into an extremely dangerous element after multiple cancer reports during the 1920s, it also seemed to damage professional reputations for those who refused to abandon it.

Despite its gradual decline in genetics, radium experiments contributed to various ways of defining mutation. Early workers thought of mutation in evolutionary terms with speciation in mind, a view that was supplanted by a focus on changes to specific genes. Geneticists exposing garden plants to radium—MacDougal, Gager and Blakeslee—argued that chromosomal and not merely genic changes had important evolutionary consequences. Drawing inspiration from the study of radiation, these geneticists also came to think of mutation in probabilistic terms. With Muller, genic mutation became the central model of genetic change and the link between mutation and transmutation was written out of the history of genetics, as Muller himself abandoned the element for X-rays, which were safer, cheaper and easier to access through hospitals. Although Campos claims that Muller had "radium-infused views of heredity" (234), and shows that his writing and drafts do indeed link mutation and transmutation, by this point the relevance of radium seems tenuous.

The final chapter discusses the decline of radium in biology, and attempts to deliver on the promise to make radium an analytical tool for the historian. By this point, we might expect that the contribution would be limited to the metaphor of half-life that can be applied to radium-crazed biologists much like their ideas about the element itself. This narrative trick does make an appearance, but is not central to the chapter. Instead, Campos offers a reflexive twist in three other ways. First, he confronts the dissatisfaction with the increasingly weak connection between radium and life as the book unfolds, claiming that this decay in consistency was part of the decline of an experimental tradition. Second, he recruits the image of the Geiger counter to describe the common historical approach of cherry-picking relevant case studies, questioning to what extent such a stochastic narrative can really do justice to the role of radiation in elaborating the metaphysics of life. Finally, he shows convincingly that while radium had left the limelight, there was plenty of fallout, or "discursive residues" (p. 253), in later discussions about mutation, chromosomes and life at large, even if the actors were often unaware of this genealogy.

The conclusion makes this reflexivity the main benefit of the work: "Starting with solid and definable case studies and then adding in ever-proliferating examples of increasingly 'suspect' historical evidence … is thus one way of highlighting the interpretive work that is always done in arranging historical sources into coherent narratives" (p. 272). It is admirable that Campos did not choose to hide the loose threads of his story, but the account remains somewhat perplexing. What remains after the well-executed reflexive turn? One wonders whether the story would hold (or, rather, unravel in the same way) if communication to broader audiences, set out strongly in the early chapters, remained in the foreground towards the end. This question aside, other historians can appreciate a fresh way to think about continuity and change, of theories, associations and models whose influence on subsequent practices can persist long after they have been abandoned. Though thinking about radium generated this approach, there is no inherent need to talk about the issues in radioactive terms. Moreover, the final paragraphs then justifiably remind the reader of the achievements of *Radium and the Secret of Life* as an intervention in the literature on radiation and genetics, generating important reflections by following a single element and its metaphoric uses.

2. Tracing tracers

Starting shortly after the experimental decline of radium, Angela Creager's expansive, at times encyclopaedic *Life Atomic* follows other radioactive isotopes that were made in cyclotrons and nuclear reactors. Radioisotopes have been commonplace in molecular biology, among other fields, but their use has attracted little historical attention. Yet, as Creager persuasively shows, these remarkable substances travelled between disciplines, government institutions, military organisations and industrial agents, and fed into both diplomatic efforts and global nuclear anxieties. The book is divided into two halves. The first discusses the production of radioisotopes in the United States in the context of atomic politics and the growth of the nuclear energy industry; the second traces their uses in various fields of biology and medicine.

Creager begins with the first production of isotopes for research, centred at Ernest Lawrence's cyclotron in the 'Rad Lab' at the University of California, Berkley. Producing radioactive elements in small quantities, Lawrence's group distributed their products within a familiar moral economy that rewarded controlled sharing. World War II transformed isotope production and promotion moved through the Manhattan project, the aftermath of Hiroshima and the construction of the first experimental nuclear reactors. Unlike most laboratory tools, the production of radioisotopes was controlled and policed by secretive federal bodies, and until 1949 the US held a monopoly.

In 1947, control over nuclear research moved to the civilian Atomic Energy Commission (AEC), which was eagerly distributing isotopes to scientists globally. In the early days, this activity was